

BOONTON
ELECTRONICS
CORPORATION



B-14

Instruction Book

Models 91H & 91HR Sensitive RF Voltmeters

For Serial Numbers 9015 and above

ERRATA No. 1

Change and amend Instruction Book Models 91H and 91HR Sensitive RF Voltmeters as follows:

Cover and title page: Delete "For Serial Numbers 9015 and above" and substitute: For Serial Numbers 8235 and above.

Page 2,

Specification chart, "Standard Equipment" item, line 6:

Change "Model 91-3B Probe Tip" to read: Model 91-13B Probe Tip.

Table II: Under the voltage range 0.001 and 0.1 columns, change the crest factor to read: 420 to 42.

Schematic diagram: Change the value of R123 to read: 845 ohms.

On models with serial numbers 9144 or higher, the value of capacitor C129 has been changed from 5 μ F, 50 V to 1 μ F, 100 V. Revise the instruction manual to reflect this change in the following places:

Page PL-1: Delete the "Description" and "BEC Part No." entries for C129 and substitute: 1 μ F 100 V 283,175.

Schematic diagram: Change the value of C129 to read: 1 100V.

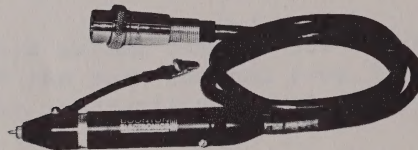
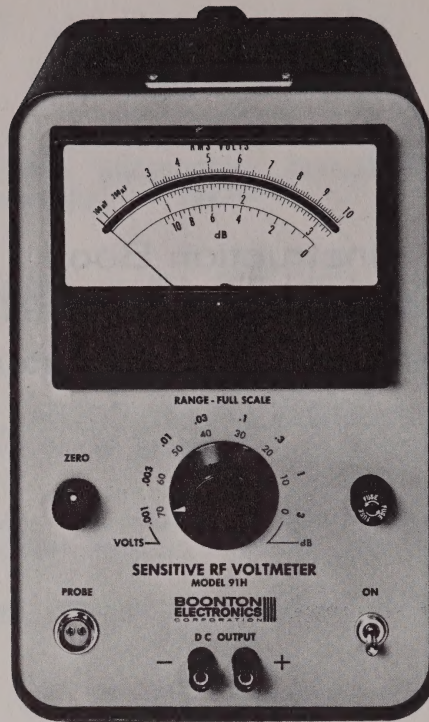
Serial Number: 9548

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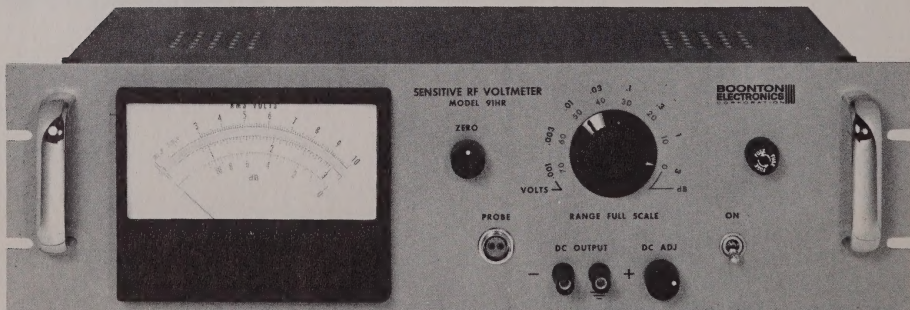
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Model 91H



Model 91HR

Models 91H and 91HR

This Instruction Book applies to both the Model 91H and 91HR Sensitive RF Voltmeters. Electrically the two instruments are identical. The Model 91HR differs physically from the Model 91H in the following ways:

1. The Model 91HR measures 19" w x 5" h (panel dimensions) x 10" d; it mounts in a standard 19-inch rack.

2. The DC ADJ control, which adjusts the dc output level, is located on the front panel of the Model 91HR rather than at the rear, as in the Model 91H.

3. Input and dc-output connections are provided at BOTH the front panel and rear panel of the Model 91HR.

4. The calibration adjustments of the Model 91HR are located along the right and left sides of the main amplifier chassis. Adjustments 1 through 6 are accessible through ports along the right side of the instrument; adjustments 7 through 11 are accessible by removing the dust cover. NOTE: In calibrating the Model 91HR, care should be taken not to leave the dust cover open longer than required while adjusting controls 7 through 11, to avoid thermal changes which could affect the accuracy of calibration.

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SECTION I
SPECIFICATIONS

<u>Voltage Measuring Range:</u>	100 μ V to 3 V; to 300 V with accessory 100:1 Voltage Divider (see Table I)
<u>Full Scale Voltage Ranges:</u>	0.001, 0.003, 0.01, 0.03, 0.1, 0.3, 1, and 3 volts
<u>Frequency Range:</u>	20 Kc/s to 1200 Mc/s; uncalibrated response beyond 4000 Mc/s
<u>Accuracy:</u>	3% from 150 Kc/s to 100 Mc/s 5% from 50 Kc/s to 400 Mc/s 10% from 20 Kc/s to 1200 Mc/s On most sensitive (0.001 V, fs) range: 5% from 150 Kc/s to 100 Mc/s 10% from 50 Kc/s to 400 Mc/s 15% from 20 Kc/s to 1200 Mc/s
<u>Noise:</u>	Indicator unrest is less than 2% fs on most sensitive (0.001 V, fs) range; sensibly zero on all other ranges
<u>DB Range:</u>	80 dB (70 dB in 10 dB steps plus 10 dB on meter scale)
<u>Waveform Response:</u>	True rms with input levels up to 30 mV; up to 3 V with accessory 100:1 Voltage Divider (see Table I); gradually approaches peak-to-peak (calibrated in rms) at higher levels
<u>Crest Factor:</u>	420 to 1.4, depending on input level (see Table II)
<u>Power Sensitivity:</u>	0.0002 microwatt, max.
<u>VSWR:</u>	Less than 1.2
<u>Linear DC Output:</u>	Proportional rf input voltage; DVM Mode, full scale values continuously adjustable from 0 to 100 mV or 300 mV depending on range numerics; REC Mode, full scale value continuously adjustable from 0 to 300 mV for all ranges; Output resistance, 0 to 40 K, depending on setting of output level control.

SPECIFICATIONS (cont'd.)

Standard Equipment: The Model 91H is supplied with the following accessories which are included in the original cost:
Model 91-12E RF Probe with low noise cable and connector assembly;
Model 91-3B Probe Tip; Model 91-8B 50 Ω BNC Adapter

Primary Power: 105/125 V, 60 c/s unless otherwise indicated on identification plate; 35 W

Mechanical Specifications: 7 1/4" W x 10 1/4" D x 11" H, excluding leather carrying handle; net weight, 12 lbs.; packed for shipment, 16 lbs.

IMPORTANT NOTE:

To exploit fully the capabilities of this instrument, the accessories listed below are required for the indicated ranges of operation:

TABLE I - REQUIRED ACCESSORIES

Measuring Range	Required Accessory	Remarks
100 Mc/s to 600 Mc/s	91-8B 50 Ω Adapter for shielded connection to 50 Ω line; other impedances available on request	Supplied as standard equipment with Model 91H
Above 600 Mc/s	91-14A Tee Connector and 91-15A 50 Ω Termination for connection into 50 Ω line	Available separately
1 Kc/s to 250 Mc/s	91-4C RF Probe	Available separately
Input levels up to 300 V; rms response with levels to 3 V	91-7C 100:1 Voltage Divider; operates over frequency range from 50 Kc/s to 700 Mc/s	Available separately

For details on the availability of these and other Boonton Electronics Accessories for RF Voltmeters, contact your local Boonton Electronics Sales Engineering Representative, or write directly to the factory at the address on the title page of this instruction book.

TABLE II - CREST FACTOR

Voltage Range	0.001	0.003	0.01	0.03	0.1*	0.3*	1*	3*
Crest Factor	140 to 42	42 to 14	14 to 4.2	4.2 to 1.4	140 to 42	42 to 14	14 to 4.2	4.2 to 1.4

*With accessory 100:1 Voltage Divider (see Table I)

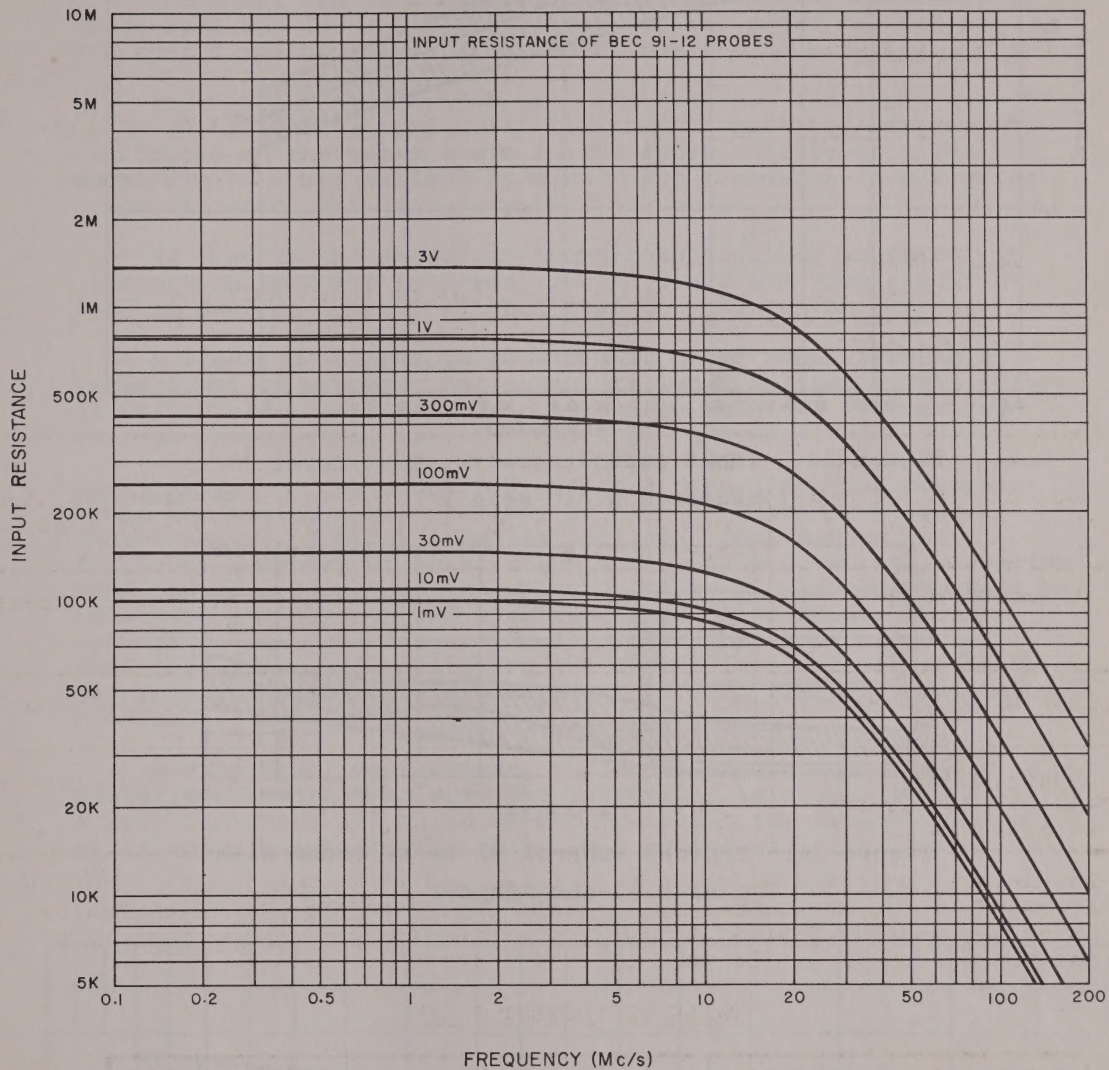


Figure 1

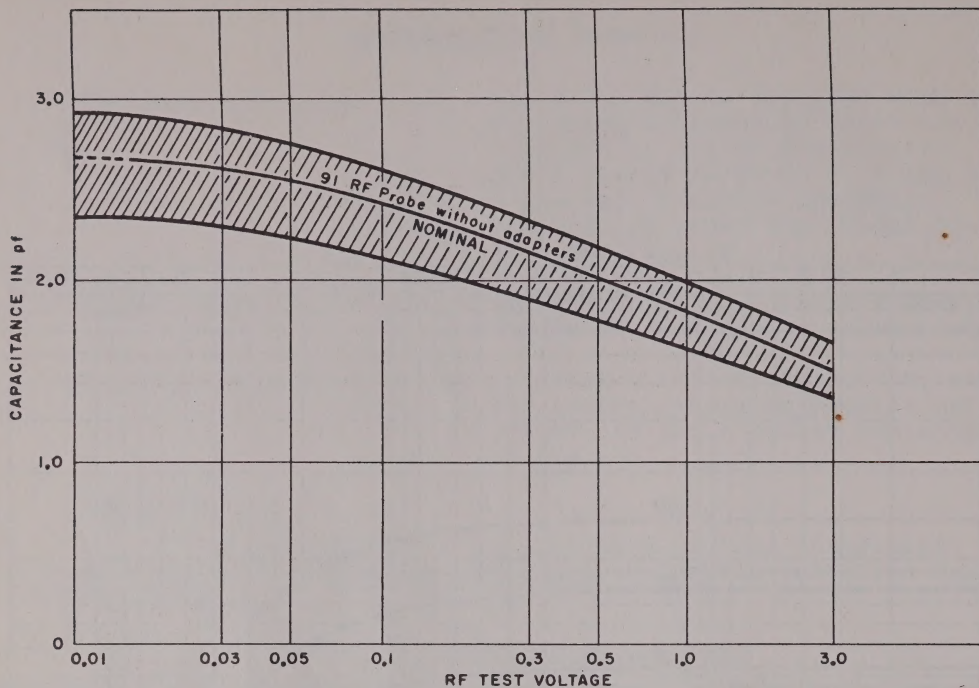


Figure 2a. Input Capacitance vs. Test Level
(measured at 10 Mc/s)

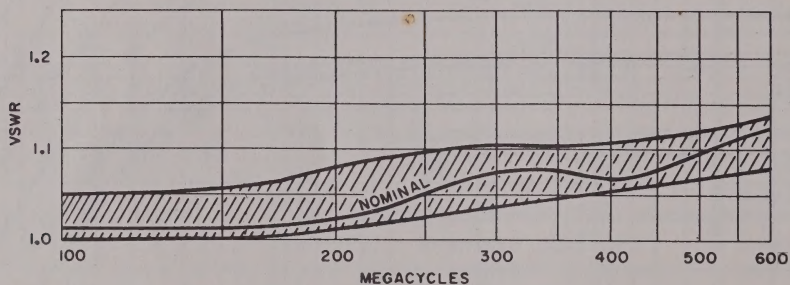


Figure 2b. Typical VSWR of 91-12 RF Probe with
91-8 50-ohm Adapter

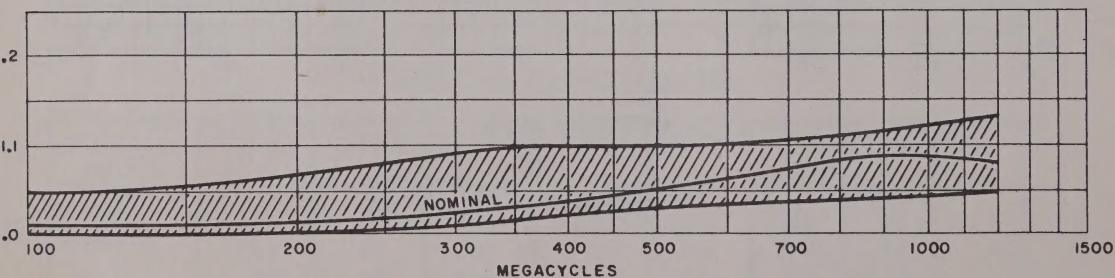


Figure 2c. Typical VSWR of 91-12 RF Probe with
91-14 Type N Tee Adapter and 91-15 50-ohm
Termination

SECTION II

General Description

The Model 91H is a highly sensitive voltmeter for measurements from the low radio frequencies to the gigacycle region, and over a voltage range from 100 microvolts to 3 volts.

The instrument provides true rms response for input signals up to 30 millivolts, gradually approaching peak-to-peak response calibrated on the meter scale in rms above this level. The Model 91H is characterized by high input impedance (see Figures 1 and 2), excellent stability, and low noise.

As long as the measuring techniques outlined in this instruction book are followed, the accuracy and VSWR specifications of Section I apply without need for correction curves.

A linear dc output is provided at front panel terminals, whose level is proportional to the rf input voltage. This output is suitable for application to recorders, digital voltmeters, voltage comparators, or other external equipment.

Applications — The Model 91H offers a convenient and accurate means for making a wide variety of high frequency voltage measurements. Typical examples include: determining the frequency response of both active and passive networks; measuring VSWR and return loss of transmission lines and attendant systems; measuring attenuation and insertion loss of RF attenuators; measuring high frequency parameters of transistors and other semiconductors; and monitoring the output level of rf signal generators and the test signal level of high frequency impedance bridges.

Having true rms response, the Model 91H is valuable for measuring broadband noise. The instrument is also useful as a peak indicator and as an RF null detector for bridge measurements where a sensitivity of 100 microvolts will suffice.

SECTION III

OPERATING PROCEDURE

IMPORTANT - This section contains information essential to successful use of the Model 91H. It should be read carefully before operating the instrument.

3.1 Installation Procedure

After the instrument has been unpacked and inspected visually for possible damage sustained in transit (if damage is found follow the instructions on the reverse side of the Warranty Notice at the back of this Instruction Book) it may be put into service by the following procedure:

a. Check the pointer zero position and if necessary adjust the mechanical zero control so that the pointer is aligned with the zero reference (the black line immediately to the left of the red 100 μ V calibration).

b. With the power cord plugged into a suitable ac power source, turn the instrument on and allow a warm-up period of approximately one minute. IMPORTANT - The instrument should be plugged only into a power source having the voltage and frequency indicated on the instrument's identification plate.

c. Connect the probe cable to the PROBE jack on the front panel. IMPORTANT - Check to see that the serial number of the probe matches that of the RF Voltmeter. Each instrument is calibrated for its particular RF Probe. Use of a probe other than that for which the instrument was calibrated may result in errors in measurement.

3.2 Operating Notes

While measuring with the Model 91H is a direct and straightforward process, there are certain precautions and procedures which **MUST** be observed to obtain satisfactory results.

3.2.1 Overload Limits - The RF Probe supplied with this instrument is overload protected to 10 volts, ac, and to 400 volts, dc. EXCEEDING THESE LIMITS MAY RESULT IN PERMANENT DAMAGE TO THE PROBE.

The Model 91-8B 50 ohm Adapter should not be subjected to continuous overload of more than 10 volts (dc + rms ac) to avoid excessive heating of the terminating resistors.

In instances where voltages above these limits are likely to be encountered, the Model 91-7C 100"1 Voltage Divider or Model 91-20A 10:1 Voltage Divider is required. Maximum rating of the Voltage Divider is 1000 volts, dc + peak ac.

3.2.2 Connection for Measurements Below 100 Mc/s - The RF Probe supplied with the Model 91H is equipped with a detachable tip and ground lead. For measurements of signals below approximately 100 Mc/s this tip provides a convenient means for both signal and ground connection.

3.2.3 Connection for Measurements above 100 Mc/s - For frequencies above 100 Mc/s, the probe tip should NOT be used. Connection should be made directly to the center contact of the probe with the ground connection kept as short as possible (see Figure 3). Under no circumstances should clip leads be used for either signal or ground connection.

Because of the difficulty in making a connection such as shown in Figure 3, the procedures outlined in Table III below are strongly recommended to maintain specified accuracy:

TABLE III

<u>Frequency</u>	<u>Signal Connection</u>
Up to 100 Mc/s	Probe Tip and grounding lead
100 Mc/s to 250 Mc/s	Probe without tip (see Figure 3)
250 Mc/s to 600 Mc/s	Probe with 91-8B 50 Ω BNC Adapter (supplied with 91H)
Beyond 600 Mc/s	Probe with 91-14A Tee Adapter and 91-15A 50 Ω Termination (see Figure 4)

3.2.4 Low Level Measurement - The Model 91H will provide reliable, reproducible measurements of signal levels as low as 100 microvolts using the red sub-calibrations on the voltage scale. (Note: These sub-calibrations are for use on the 0.001 V range only. They should not be used for measurements on any other voltage range.)

When using the most sensitive range (0.001 V), preliminary zero adjustment is required. On the 0.001 V range, particularly for measurements below mid-scale, proper zero adjustment is essential to achieve specified accuracy. For up-scale readings on this range zero adjustment is less critical, although still recommended.

3.2.5 Making the Zero Adjustment - When the instrument is to be used on the 0.001 V range, the following zero adjustment procedure applies:

- a. Set the RANGE FULL SCALE selector to the 0.001 V position.
- b. Check to see that no voltage is applied to the probe, and that the probe is adequately shielded

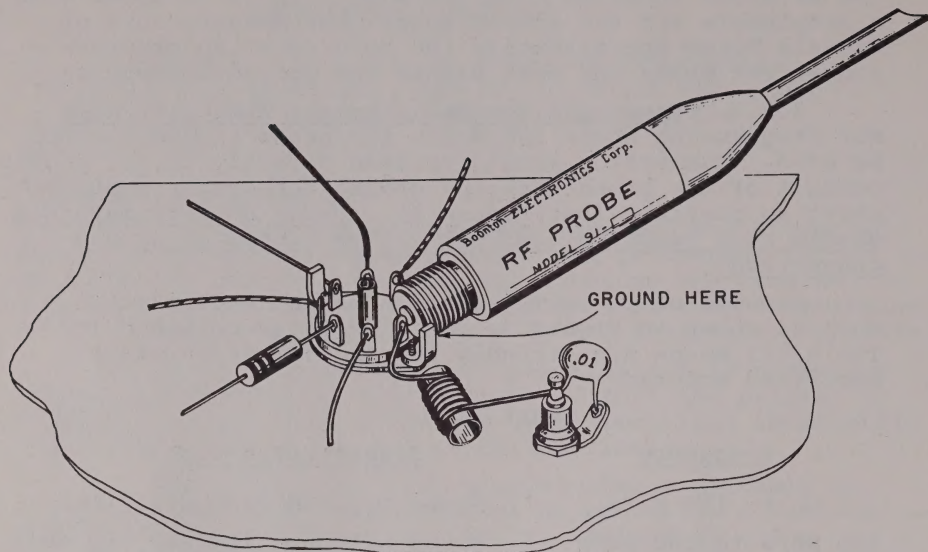


Figure 3. Method for making low inductance connections to test signal point directly using the RF Probe. Use for in-circuit measurements when lowest capacitance loading is required or when ground lead inductance of Probe Tip cannot be tolerated.

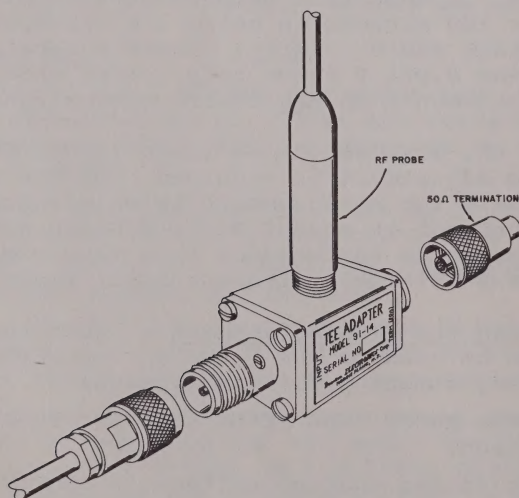


Figure 4. Assembly of 91-14 Type N Tee Adapter

from local fields (for test procedure, see paragraph 3.2.9).

c. Adjust the ZERO control to bring the pointer in the direction of the zero reference (the black line immediately to the left of the red 100 μ V calibration). Since there is some delay between adjustment of the control and the motion of the pointer, over-or-under-shooting the zero reference on the first attempt is not unlikely. After this initial coarse adjustment, wait for a moment or two for the pointer to come to rest. Then apply a series of small, corrective adjustments, waiting between each for the pointer to assume its new position until proper zeroing is achieved.

Note: Because of the great sensitivity of the instrument on this range, indicator fluctuation of $\pm 2\%$ of full scale or less is to be expected. Proper zero adjustment is achieved when the pointer fluctuates equally above and below the zero reference line.

3.2.6 Normal Pointer Rest Position - Depending on the range setting, the pointer may or may not normally rest at the zero reference with no signal applied. The rest positions indicated below are proper for the particular range; they do not indicate a need for either electrical or mechanical re-zeroing.

<u>FS Range</u>	<u>Rest Position</u>
0.001 V	Adjusted to zero reference (see above)
0.003 V	Approx. 1/16 inch up-scale
0.01, 0.03, 0.1, 0.3, 1 V	At zero reference
3 V	Approx. 1/16 inch down-scale

3.2.7 Signal Overload on 0.001 V Range - On the most sensitive (0.001 V) range, application of a large ac signal overloads the amplifier and a short time is required for the high impedance input circuit to discharge. This effect is of significance for signals above approximately 100 millivolts. Typically, application of a 1 volt signal will require a recovery time of about one minute before subsequent measurements should be made. It should be noted, however, that such overloads cause no damage to the equipment as long as they are within the limits outlined in paragraph 3.2.1.

3.2.8 Temperature Effects - The accuracy specifications for the Model 91H apply over the temperature range from 65° F to 90° F. Outside of these limits operation of the equipment is possible but appreciable inaccuracies can be expected. However, no permanent change in probe characteristics will result from any reasonable high or low temperature exposure.

It should be noted that inaccuracies of measurement resulting from temperature effects may occur shortly after soldering to the probe tip, or measuring with the probe in the vicinity of heat sources such as resistors, heat sinks, vacuum tubes, etc.

When making low level measurements (below approximately 2 millivolts) it is important to make sure that the probe has attained a uniform temperature throughout its body. A temperature gradient between the inside and outside of the probe can generate a small thermal voltage that may add or subtract with the dc output generated by the detector diodes.

3.2.9 Hum, Noise, and Spurious Pick-up - When measuring low level signals precautions should always be taken to avoid the possibility of errors of measurement resulting from hum, noise, or stray rf pick-up. Although all low frequency hum and noise are attenuated at the input, it is still possible for unwanted high level signals to cause errors. The best test for local pick-up is to reduce the test signal level to zero and then note whether the pointer comes to the rest position appropriate for the range setting (see paragraph 3.2.6, above). In some cases it may be necessary to provide extra shielding around the probe connections to reduce stray pick-up. Typical sources of spurious radiation are: induction or dielectric heating units, diathermy machines, local radio transmitters, grid dip meters, and amplifiers with parasitic oscillations.

3.3 Linear DC Output

The dc output provided at front panel binding posts is a linear function (typically within 1%) of the rf input level, as long as the input signal is greater than 300 microvolts. For inputs less than 300 microvolts the output is NOT linear, and its use is not recommended. Polarity of the dc output is negative with respect to the instrument ground, the positive dc output terminal being at ground potential. Output impedance is less than 40 K, depending on output level setting.

3.3.1 DC Output Modes - The linear dc output is available in two modes to meet the needs of various requirements. Mode selection is accomplished by jumper connections at the rear of the instrument.

a. REC (Recorder) Mode - In the REC Mode, the dc output is continuously adjustable from 0 to 300 millivolts, full scale, on all ranges.

b. DVM (Digital Voltmeter) Mode - In the DVM Mode, full scale value of the dc output is continuously adjustable from zero to 100 millivolts for all "1" ranges, and to 300 millivolts for all "3" ranges, with the full scale value following the scale numerics when switching ranges.

3.3.2 Adjustment of DC Output Level - Full scale value of the dc output can be adjusted within the specified limits (see Table I) by applying an rf signal to the input which produces full scale deflection, and adjusting the DC OUTPUT LEVEL control (at rear panel) while monitoring the output with a high impedance dc voltmeter, such as the Boonton Electronics Model 95A, 97A, or 98A.

Adjustment of the dc output level has no influence on the instrument's calibration accuracy. A full short circuit across the dc output terminals does not effect the meter reading.

3.4 Low Frequency Measurements

The Model 91-12E RF Probe supplied with this instrument provides measurements within the specified accuracy from 20 Kc/s to 1200 Mc/s. For measurements at lower frequencies the Model 91-4C Probe is available. It operates over a frequency range from 1 Kc/s to 250 Mc/s. Important Note: After installing the Model 91-4C Probe, the RF Voltmeter must be checked for accuracy of calibration, and recalibrated if required (see paragraphs 5.3 and 5.4).

SECTION IV

Theory of Operation

An understanding of the operation of the Model 91H RF Voltmeter may be gained from the Block Diagram of Figure 5. The instrument comprises essentially a solid state detector probe, a highly sensitive, stable, chopper type dc amplifier, and a dc voltmeter.

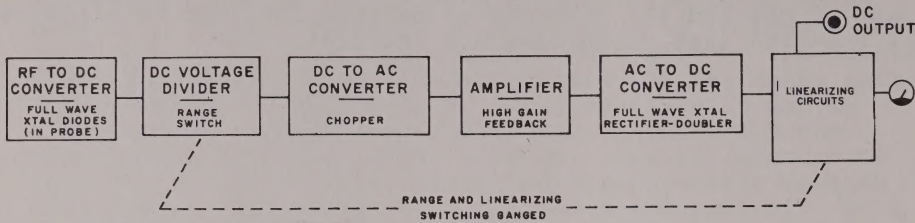


FIGURE 5. Block Diagram, Model 91H

4.1 RF Probe

The RF Probe embodies a full wave diode detector which rectifies the signal under study to a dc voltage whose level is a function of the input level. While operating in the square-law region (below approximately 30 millivolts) the detector provides true rms response. As the input level increases beyond 30 millivolts, waveform response gradually approaches peak-to-peak, calibrated on the scale in rms.

In addition to increasing efficiency, use of full wave rectification in the detector probe permits measurement of signals having highly asymmetrical waveforms without errors stemming from turn-over effect.

The diodes used in the RF Probe have been carefully selected for specific characteristics. The user is urged NOT to attempt their replacement with any off-the-shelf types. In case of damage to probe components, contact your local Boonton Electronics Sales Engineering Representative or the factory for instructions.

4.2 Amplifier

The dc output from the probe is passed through a voltage dividing network (range selector) where it is attenuated as required before being converted to ac at power-line frequency by the low noise chopper. The chopper output is applied to the narrow band, feed-back stabilized amplifier. Filter net-

works at the input, centered at line frequency, greatly attenuate extraneous noise and rf pick-up to the point where special precautions to avoid the effects of external fields are required only under the most unusual circumstances.

The ac output from the amplifier is then rectified by a voltage doubler and passed through a diode network to convert the signal to a linear voltage suitable for metering. The output of the linearizing network is also available at front panel terminals for external use.

SECTION V

Maintenance

5.1 Periodic Calibration

The Model 91H is designed to provide trouble-free operation over extended periods of time. However, as is the case with any precision instrument, the Model 91H should be checked periodically to verify proper calibration. To make such calibration checks, the following equipment is required:

- a. A reliable signal source of 200 Kc/s to 500 Kc/s with less than 1% distortion at levels up to 3 volts across 50 Ω .
- b. A precision electronic voltmeter of the averaging type such as the Ballantine Model 310A or 314, or the Hewlett-Packard Models 400D or 400H.

5.2 Precautions When Checking Calibration

Before checking calibration, the accuracy of the ac monitoring meter should be verified using a low frequency (50 - 100 c/s) source of good waveform and a dynamometer type ac meter of at least 1% accuracy.

When checking the calibration on an instrument having the sensitivity and bandwidth of the Model 91H, it is essential to take precautions to avoid errors resulting from stray pick-up voltages. (See paragraph 3.29) A well shielded signal source must be used in conjunction with coaxial connections to both the Model 91H and the standard reference meter. Even with a well shielded generator and associated connections, it is sometimes possible for the reference meter to pick up stray RF signals and feed them into the probe. It is advisable to test for this condition by disconnecting the standard meter and noting any change in level.

5.3 Calibration Check

Using the equipment reference in paragraph 5.1 and observing the procedure outlined in paragraph 5.3, the calibration of the Model 91H should be checked on each range using a test voltage equal to the full scale value. If the check reveals that recalibration is required, the procedure outlined in paragraph 5.4 should be followed.

5.4 Calibration Procedure

The Model 91H should be calibrated only when it is fully warmed up (after at least 30 minutes). DO NOT REMOVE THE INSTRUMENT FROM ITS CASE FOR CALIBRATION.

Access ports to all calibration controls are located along the lower right and left sides of the instrument. The control identification numbers referenced in the following procedure appear on the plates mounted just above the access ports.

Step 1. Set RANGE-FULL SCALE selector to 0.001V range and zero the instrument. (See paragraph 3.25.)

Step 2. Set RANGE-FULL SCALE selector to 1V range; set control #2 fully clockwise; apply 0.3V input; adjust control #1 for 0.3V reading.

Step 3. On 1V range, apply 0.9V input and adjust the control #2 for 0.9V reading.

Step 4. On 1V range, apply 0.3V input again and readjust control #1 for 0.3V reading.

Step 5. On 1V range, apply 0.9V input again and readjust control #2 for 0.9V reading.

Step 6. Alternately repeat steps 4 and 5 until range is calibrated (when adjustment of one control ceases to require readjustment of the other).

Step 7. Set RANGE-FULL SCALE selector to 3V range. Apply 2.5V input and adjust control #3 for 2.5V reading.

Step 8. Set RANGE-FULL SCALE selector to 0.3V range. Apply 0.25V input and adjust control #4 for 0.25V reading.

Step 9. Set RANGE-FULL SCALE selector to 0.1V range. Apply 0.09V input and adjust control #5 for 0.09V reading.

Step 10. Set RANGE-FULL SCALE selector to 0.01V range. Apply 0.003V input and adjust control #6 for 0.003V reading.

Step 11. Without altering range setting, apply 0.006V input, and adjust control #7 for 0.006V reading.

Step 12. Without altering range setting, apply 0.009V input, and adjust control #8 for 0.009V reading.

Step 13. In sequence, repeat steps 10, 11, and 12 several times, until range is calibrated.

Step 14. Set RANGE-FULL SCALE selector to 0.03V range. Apply 0.03V input and adjust control #9 for 0.03V reading.

Step 15. Set RANGE-FULL SCALE selector to 0.003 V range. Apply 0.0025 V input and adjust control #10 for 0.0025 V reading.

Step 16. Adjust ZERO as in Paragraph 3.2.5.

Step 17. Set RANGE-FULL SCALE selector to 0.001 V range. Apply a 0.0009 V input and adjust control #11 for 0.0009 V reading.

Step 18. Alternately repeat Steps 16 and 17 until range is calibrated.

Calibration of the Model 91H is now complete, except for a brief check, as outlined in Paragraph 5.3 to assure that the calibration has been properly accomplished.

5.5 Trouble Shooting Procedure

5.5.1 Case Removal - The instrument may be removed from its case after first removing the two screws located at the back of the case (near the bottom) and the four screws located on the sides of the case near the front.

The power supply may be removed from the case after removing the four screws located on the sides of the case near the rear.

5.5.2 Tube Replacement - If the tube V1 should become weak or noisy, it should be replaced with BEC 525001 or a commercial low noise 12AX7. The Telefunken ECC83/12AX7 has been found to meet these requirements consistently. After replacing defective tubes, check calibration as outlined in Paragraph 5.3 and calibrate, if necessary, as described in Paragraph 5.4.

5.5.3 Chopper Replacement - If satisfactory operation is not obtained by replacing tubes, a replacement chopper should be tried. (NOTE: The chopper used in the Model 91H is a special BEC part. For replacements or spares, contact your local Boonton Electronics Representative, or call the factory directly.) If the new chopper does not clear the difficulty, place the original chopper back in socket. The calibration accuracy must be re-checked and, if necessary, the instrument should be recalibrated.

5.5.4 Voltage and Resistance Tests - After determining that the trouble cannot be cured by replacement of tubes or chopper (as described above) it is advisable to make a systematic check of the ac voltage, dc voltage, and resistance to ground from each pin of each tube socket. Table IV shows the nominal ac and dc voltages to ground from each pin; Table V shows the nominal resistances to be expected at each point. Large or erratic deviations from the listed values will serve as a valuable clue in tracking down a faulty component. Once the trouble has been found and corrected, the calibration must be re-checked and readjusted as outlined in Paragraph 5.3 and Paragraph 5.4.

TABLE IV

VOLTAGE MEASUREMENTS

Conditions:

117V 60 ϕ line input.

VTVM used for all measurements.

All measurements to chassis unless otherwise noted.

Input 0.01V at any frequency between 100 Kc and 1 Mc.

Use Ballantine Model 314 VTVM for all AC voltage measurements.

RANGE-FULL SCALE selector set to 0.01V range.

Pin #	1	2	3	4	5	6	7	8	9	10	11
Tube	141 140V	36mV 1.5mV	.749 0.6V 0.1V	.879 0.75V 1.5mV	6.3V 6.11	72.4 85V 0.1V	0	0.8V .890	0	-	-
V101 Ass'y	DC	1.5	12.6	6.3	11	24	1.5	-	-	-	-
V102 (6AU6)	AC	0.1	0.4	25mV	0.5	0.15	0.1	-	-	-	-
V103 (7199)	DC	300	45	0	0	1.5	0	170	100	-	-
	AC	0.4	1V	0	6.3	5mV	70mV	20	20	-	-
V201 (6X4)	DC						350				
	AC	340	6.3	0		340					
V202 (0A2)	DC	150			150						
	AC										
11 Pin Socket	DC										
	AC	6.3	0				150	300	0	0	12.6
Chopper Socket	DC										
	AC		1.5mV	1.5mV							
Pin 10 to Pin 11 of 11 Pin Socket	DC		12.6								
	AC		0.4								
Pin 10 to Pin 5 of 11 Pin Socket	DC		+6.3								
	AC		0.4								

TABLE V
RESISTANCE MEASUREMENTS

Conditions:

Power turned off.

Tubes in socket, chassis interconnected (11 Pin), all measurements to chassis.

Pin #	1	2	3	4	5	6	7	8	9	10	11
Tube											
V101 Ass'y	65K	6.8M	835K	11K	4Ω	500K	100Ω	6.8K	0	-	-
V102 (6AU6)	835K	3.8K	8Ω	4Ω	500K	1M	3.8K	-	-	-	-
V103 (7199)	30K	250K	1M	0	0	1.2K	1M	20K	1M	-	-
V201 (6X4)	250	-	0	0	-	250	30K	-	-	-	-
V202 (OA2)	20K	0	-	0	20K	-	0	-	-	-	-
11 Pin Conn.	0	0	∞	∞	4Ω	-	20K	30K	0	8Ω	4Ω

5.5.5 Replacement of DC Output Level Potentiometer (R151) - If it should become necessary to replace the dc output level control (R151), it is possible that R150 will require replacement as well. R150 is selected to provide maximum accuracy of dc output in the DVM Mode when switching from a "1" range to a "3" range, or vice versa. If R151 is replaced, check to see that full scale dc output values alternate exactly between 100 and 300 millivolts when switching from "1" to "3" ranges. Otherwise, select a value for R150 which will accomplish this.

5.5.6 Replacement of RF Probes - The serial number of the instrument matches that of this RF Probe with which it was calibrated at the factory. If it is necessary to change probes for any reason, the instrument's calibration MUST be rechecked. In the majority of cases, full recalibration (see procedure in paragraph 5.4) will be required. Similarly, if the RF Probe supplied with the instrument is exchanged for a Model 91-4C Low Frequency Probe, recalibration will be required. (See paragraph 3.4.)

5.5.7 Replacement of XV101 Assembly - The components making up the XV101 Assembly of this instrument have been incorporated in a module which may be removed as a unit in the following manner:

Remove V101. Remove the screws securing the base shield of V101 and remove the base shield. The RFI Module, of which the socket is a part, may now be withdrawn from the chassis. The Module is force fit in its shield, from which it can be removed by pulling the shield down from the socket.

The RFI Filter Module is available for replacement as an assembled unit, and is designated by the BEC part number: 091,870.

91H

TABLE OF REPLACEABLE PARTS

<u>Reference</u>		<u>Description</u>				<u>BEC Part No.</u>
C101	Capacitor,	0.1	μF	50 V	10%	234,046
C102	"	0.1	μF	50 V	10%	234,046
C103	"	0.1	μF	50 V	10%	234,046
C104	"	0.1	μF	50 V	10%	234,046
C105	"	0.022	μF	200 V	20%	234,042
C106	"	.05	μF	200 V		230,117
C107	"	0.0033	μF	200 V	10%	234,043
C108	" Elect.	50	μF	6 V		283,145
C109	"	0.0033	μF	200 V	10%	234,043
C110	" Elect.	30	μF	350 V		283,161
C111	" Elect.	50	μF	6 V		283,145
C112	"	0.1	μF	200 V	20%	230,116
C113	"	0.022	μF	200 V	20%	230,101
C114	"	0.1	μF	200 V	20%	230,116
C115	"	0.1	μF	200 V	20%	230,116
C116	"	0.047	μF	200 V	5%	234,026
C117	"	50	μF	6 V		283,145
C118	"	0.002	μF	200 V	5%	234,024
C119	"	0.033	μF	200 V	5%	234,025
C120	"	0.033	μF	200 V	5%	234,025
C121	"	100	μF	6 V		283,171
C122	"	0.5	μF	200 V		230,135
C123	"	0.022	μF	200 V	20%	230,101
C124	"	0.1	μF	200 V	20%	230,116
C125	"	0.1	μF	200 V	20%	230,116
C126	" Elect.	50	μF	6 V		283,145
C127	"	0.1	μF	200 V	20%	230,116
C128	"	1	μF	200 V		230,104
C129	" Elect.	50	μF	50 V 100		283,143 175 Em
C201	"	3X20	μF	450 V		283,113
C202	"	2X1000	μF	15 V		283,114
CR101	Diode, Silicon		1N251			530,043
CR102	"		SG3113			530,040
CR103	"		1N600			530,008
CR104	"		1N600			530,008
CR105	"		SG3113			530,040
CR106	"		SG3113			530,040
CR201	Rectifier	Sarkes	Tarzian			532,001

PL-1

91H

b

	<u>Reference</u>	<u>Description</u>	<u>BEC Part No.</u>
DS101	Lamp	GE #51	545,103
DS102	Lamp	GE #51	545,103
F101	Fuse	MDL-0.5 Amp	545,504
G101	Chopper	BEC Special	540,113
L101	R.F. Coil	4.7 μ H	400,113
L103	R.F. Coil	470 μ H	400,116
L201	Choke	Stancor #C-1707 7 HY	440,001
M101	Meter	190 μ A	554,161
R101	Resistor,	675 Ω 1/2 W 1%	306,695
R102	"	1.39 K 1/2 W 1%	306,694
R103	"	6.65 K 1/2 W 1%	306,338
R104	"	45.3 K 1/2 W 1%	306,437
R105	"	511 K 1/2 W 1%	306,564
R106	"	5.11 M 1/2 W 1%	306,788
R107	"	330 K 1/2 W 5%	301,147
R108	"	675 Ω 1/2 W 1%	306,695
R109	"	1.39 K 1/2 W 1%	306,694
R110	"	6.65 K 1/2 W 1%	306,338
R111	"	45.3 K 1/2 W 1%	306,437
R112	"	511 K 1/2 W 1%	306,564
R113	"	5.11 M 1/2 W 1%	306,788
R114	"	330 K 1/2 W 5%	301,147
R115	"	2.2 K 1/2 W 5%	301,095
R116	"	10 Ω 1/2 W 5%	301,039
R117	"	120 Ω 1/2 W 5%	301,065
R118	"	2.7 K 1/4 W 5%	300,092
R119	"	6.8Meg Ω 1/4 W 5%	300,174
R120	" Var.	50 K	311,125
R121	"	10 Ω 1/2 W 5%	301,039
R122	"	1 Meg Ω 1/2 W 5%	301,159
* R123	"	845 Ω 1/2 W 1%	306,231
R124	"	10 K 1/2 W 1%	306,359
R125	"	825 K 1/2 W 1%	306,589
*R126	"	220 K 1/2 W 5%	301,143
R127	"	6.8 K 1/4 W 5%	300,102
R128	"	2.2Meg Ω 1/4 W 5%	300,162
R129	"	100 Ω 1/2 W 5%	301,063
R130	"	470 K 1/4 W 5%	300,146

Reference		Description					BEC Part No.
R131	Resistor,	6.8	K	1/2	W	5%	301,107
R132	"	47	K	1/2	W	5%	301,127
R133	"	1	K	1/4	W	5%	300,082
R134	"	3.9	K	1/2	W	5%	315,002
R135	" Var.	5	K	2	W	20%	311,101
R136	"	470	K	1/2	W	5%	301,151
R137	"	1	M	1/2	W	5%	301,159
R138	" Var.	2	K	2	W	10%	311,126
R139	" Var.	5	K	2	W	20%	311,101
R140	"	200	K	1/2	W	5%	301,142
R141	"	200	K	1/2	W	5%	301,142
R142	"	560	K	1/2	W	5%	301,153
R143	"	51	K	1/2	W	5%	301,128
R144	"	576	K	1/2	W	1%	306,570
R145	"	43	K	1/2	W	5%	301,126
R146	"	68	K	1/2	W	5%	301,131
R147	"	20	K	1/2	W	5%	301,118
R148	"	1	MegΩ	1/2	W	5%	301,159
R149	"	100	K	1/2	W	5%	301,135
*R150	"	8.2	K	1/2	W	5%	301,109
R151	" Var.	50	K	2	W	10%	311,208
R152	"	51	K	1/2	W	5%	301,128
R153	"	51	K	1/2	W	5%	301,128
R154	" Var.	50	K	2	W	20%	311,163
R155	" Var.	25	K	2	W	20%	311,115
R156	" Var.	25	K	2	W	20%	311,115
R157	" Var.	25	K	2	W	20%	311,115
R158	" Var.	25	K	2	W	20%	311,115
R159	"	1.2	K	1/2	W	5%	301,089
R160	"	220	K	1/2	W	5%	301,143
R161	" Var.	250	K	2	W	20%	311,103
R162	"	330	Ω	1/2	W	5%	301,075
R163	"	1	MegΩ	1/2	W	5%	301,159
R164	"	1	MegΩ	1/2	W	5%	301,159
R165	"	680	Ω	1/2	W	5%	301,083
R166	"	3.3	K	1/2	W	5%	301,099
R167	"	20	K	2	W	5%	304,118
R168	"	4.7	K	1/2	W	5%	301,103
R169	" Var.	10	K	2	W	20%	311,102
R170	"	30	K	1	W	5%	302,136
R171	"	4.7	K	1/2	W	5%	301,103
R172	"	100	K	1/2	W	5%	301,135

	<u>Reference</u>	<u>Description</u>	<u>BEC Part No.</u>
R173	Resistor, Var.	2 Meg Ω 2 W 20%	311,195
R174	"	30.1 K 1/2 W 1%	306,416
R175	"	68 K 1/2 W 5%	301,131
R176	"	9.53 K 1/2 W 1%	306,357
R177	"	33.0 K 1/2 W 5%	301,123
R201	"	1 Meg Ω 1 W $\pm$ 20%	302,128
R202	"	5.6 K 2 W 5%	304,105
R203	"	10 K 10 W 5%	312,103
S101	Switch	Oak Type F	466,169
S102	Switch	SPST Carling 110-63	465,105
T201	Transformer	Power, Special	446,016
V101	Electron Tube	12AX7, Special	525,001
V102	Electron Tube	6AU6	526,6AU6
V103	Electron Tube	7199	526,7199
V201	Electron Tube	6X4	526,6X4
V202	Electron Tube	OA2	526,OA2
VR101	Diode, Zener	5.4 V 1/2 W 5%	530,020

*The following items are factory selected values.

Addendum for 91H-HR

S/N 8235 and above

In redesigning the XV101 Assembly to a plug-in module, it was necessary to renumber the pin connections. These pin numbers will be in error on schematics below Issue G, on Voltage Measurements Table IV below Issue C, and on Resistance Measurements Table V below Issue C.

They may be corrected as follows:

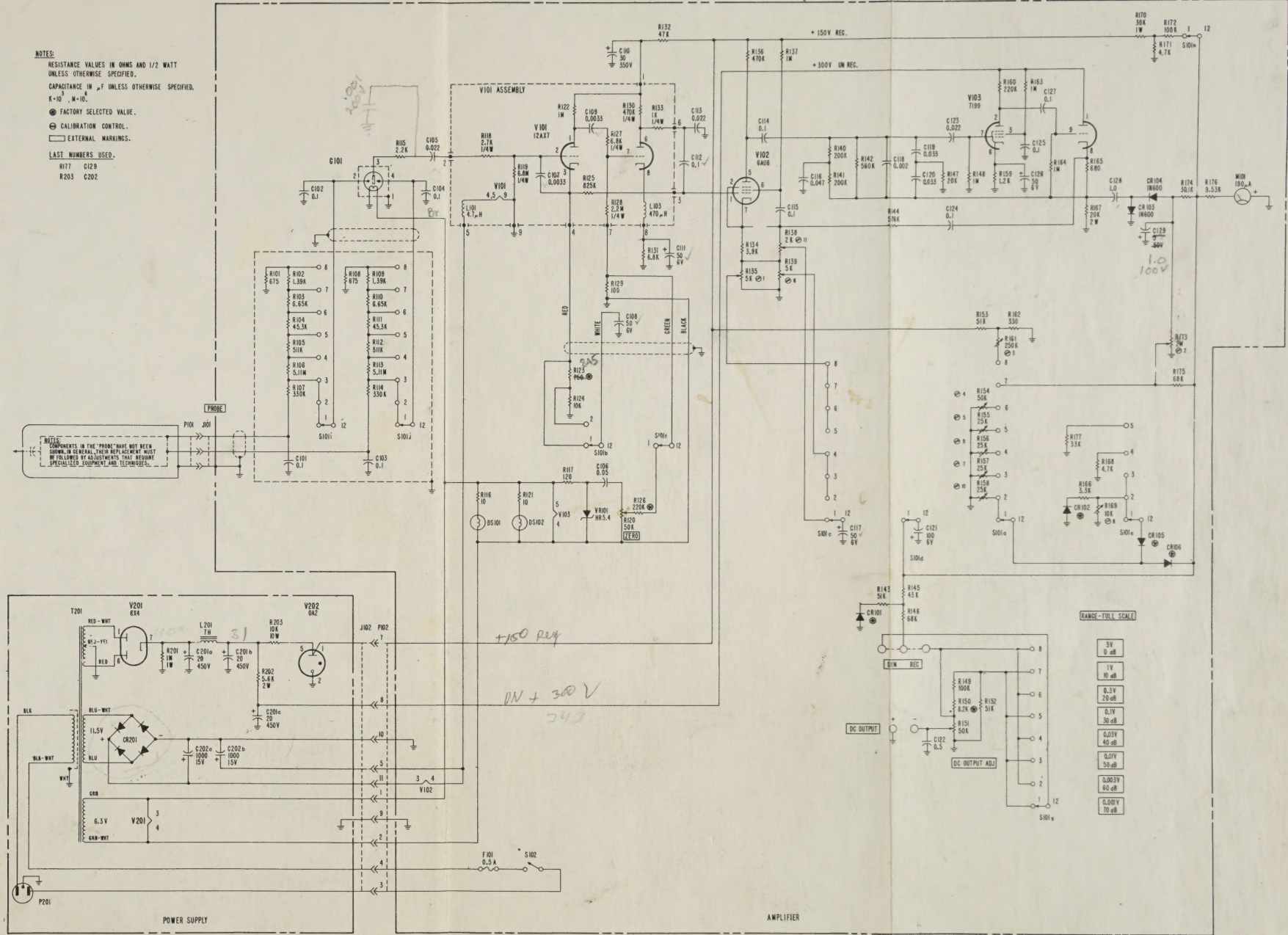
<u>Original Pin Numbers</u>	<u>New Pin Number</u>
1	7
2	8
3	
4	2
5	3
6	4
7	5
8	6
Gnd	9

Also, the coil in the cathode of the first amplifier stage, L102, has been removed. Pin 3 of XV101 is connected directly to Pin 3 of the XV101 Assembly module.



Drawing No. 830,326 H

NOTES:
 RESISTANCE VALUES IN OHMS AND 1/2 WATT
 UNLESS OTHERWISE SPECIFIED.
 CAPACITANCE IN μ F UNLESS OTHERWISE SPECIFIED.
 K=10³, M=10⁶.
 ● FACTORY SELECTED VALUE.
 ⊕ CALIBRATION CONTROL.
 □ EXTERNAL MARKINGS.
 LAST NUMBERS USED:
 R177 C129
 R203 C202

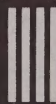


Abridged
Catalog
CC-11

Electronic Instruments for Laboratory and Production



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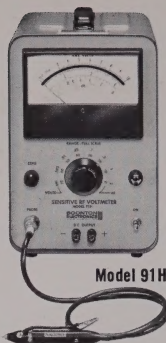




Model 91DA

Sensitive RF Voltmeters

The 91 Series RF Voltmeters provide reliable, reproducible voltage measurements from the low radio frequencies to the gigahertz region over a wide range of amplitudes. The versatility of these instruments plus their accuracy and convenience of operation have established them as standards of performance for the industry. The primary differences between the Models 91DA, 91H and 91C are indicated in the specification table below. All three models are characterized by low noise, excellent stability, high input impedance, and low input capacitance.



Model 91H

	Model 91DA	Model 91H	Model 91C
Voltage Range:	1 mV fs to 3 V fs*	1 mV fs to 3 V fs*	3 mV fs to 3 V fs*
	*to 300 V with Model 91-7C 100:1 Voltage Divider		
Voltage Sensitivity:	300 μ V	100 μ V	1 mV
Power Sensitivity, (50 Ω):	0.0018 μ W	0.0002 μ W	0.02 μ W
Basic Accuracy:	$\pm 2\%$, fs	$\pm 3\%$, fs	$\pm 5\%$, fs
Frequency Range:	20 KHz to 1200 MHz, with uncalibrated response to 4000 MHz		
VSWR:	Less than 1.2 up to 1200 MHz for all Models		
Waveform Response:	True rms up to 0.03 V (to 3 V with accessory 100:1 Voltage Divider) gradually approaching peak-to-peak (calibrated in rms) above this level.		
DC Output	yes	yes	no
dB Range	80 dB	80 dB	70 dB
Price:	\$650.00** \$750.00†	\$595.00**	\$495.00**

*Includes 91-12E RF Probe, 91-13B Probe Tip, and 91-8B 50 ohm Adapter

†With complete Accessory Kit, consisting of 91-12E RF Probe, 91-13B RF Probe Tip, 91-6C Underterminated BNC Adapter, 91-7C 100:1 Voltage Divider, 91-8B 50 ohm Adapter, 91-14A Tee Adapter, 91-15A 50 ohm Termination, all in 91-18A Accessory Storage Box.

Accessories for RF Voltmeters:

		Price
91-4C	1 KHz to 250 MHz Probe	\$65.00
91-6C	Underterminated BNC Adapter	20.00
91-7C	100:1 Voltage Divider (50 KHz to 700 MHz)	35.00
91-8B	50 Ω BNC Adapter (20 KHz to 600 MHz; other impedances also available)	25.00
91-12E	20 KHz to 1200 MHz Probe	45.00
91-13B	RF Probe Tip	3.00
91-14A	Type N "Tee" Adapter (20 KHz to 1200 MHz)	35.00
91-15A	50 Ω Type N Termination (20 KHz to 1200 MHz)	25.00
91-16A	Underterminated Type N Adapter	20.00
91-18A	Accessory Storage Box	10.00



Sensitive DC Null Detector Model 56A

Electronic galvanometer providing exceptionally high sensitivity and high input impedance. Especially valuable as indicator in conjunction with Wheatstone

Bridge. Either floating or grounded operation. Zero-center scale. 60 dB scale compression in Hunt mode virtually eliminates range switching when measuring specimens of unknown value. Provision for remote Hunt mode switching. Amplifier output available at front panel terminals.

Voltage Range: 10 μ V to 100 V, end scale, in 8 ranges; sensitivity, 1 μ V

Current Range: 1 pA to 10 μ A, end scale; sensitivity, 0.1 pA

Input Resistance: 10 M Ω , all ranges

Operating Modes: Hunt (60 dB meter scale compression); Calibrate (linear meter scale)

Amplifier Output Capability: ± 1 mA dc into 1000 Ω

Amplifier Gain: -40 to +100 dB.

Price: \$495.00 (rack mounted Model 56A-R, \$520.00)



RF Microwattmeter Model 41A

Exceptionally stable microwave power meter providing reliable measurements over a 70 dB range with one power detector. Use of full wave diode detector overcomes limitations of stability, sensitivity, and overload of thermal types. No zero balancing except for fractional microwatt measurements. Can be calibrated from low frequency rf source. Stable dc output.

Power Range: 0.01 μ W (-50 dBm) fs to 10 mW (+10 dBm) fs

Power Sensitivity: 0.001 μ W (-60 dBm)

Frequency Range: 100 KHz to 7 GHz

Basic Accuracy: ± 0.5 dB

Drift: Less than 0.001 μ W per hour

VSWR: 1.3 to 3 GHz; 1.5 to 6 GHz; 1.8 to 7 GHz

Overload Limit: Input of 300 mW cw does not cause damage

Price: 41A, \$695.00; rack mounting Model 41A-R, \$720.00



Sensitive DC Microvolt/Picoammeter Model 95A

Unusually broad range of dc voltage and current measurements covered in 42 ranges. Front panel range and function switching uniquely simple and convenient. Zero center meter. Fast response. Exceptionally stable amplifier output at front panel. Amplifier output gain and reference level adjustable without interaction with meter. Either floating or grounded operation for voltage; floating for current.

Voltage Range: 10 μ V to 1000 V, end scale; accuracy, $\pm 3\%$; sensitivity, 1 μ V

Current Range: 1 pA to 1 A, end scale; accuracy, $\pm 4\%$; sensitivity, 0.1 pA

Voltmeter Input Resistance: 10 M Ω , all ranges

Amplifier Output: ± 1 V, end scale, across 1000 Ω

Amplifier Gain: 100,000 max

Price: \$550.00 (rack mounted Model 95A-R, \$575.00)

BOONTON ELECTRONICS CORPORATION

Domestic Price List *Instruments & Accessories*

Effective Date: Dec. 15, 1967
Superseding issue of June 1, 1967

INSTRUMENTS

Model	Unit Price	Description
33A	\$ 2,500.	RF Admittance Bridge (0 to 150 pF)
33B	3,000.	Ultra-high Conductance Resolution Admittance Bridge (0 to 5000 μ mhos)
33C	2,650.	Ultra-high Capacitance Resolution Admittance Bridge (0 to 15 pF) (Formerly 33A-S7)
33D	3,150.	Ultra-high Capacitance and Conductance Resolution Admittance Bridge (0-15 pF; 0 to 5000 μ mhos)
35A	3,000.	Q Bridge
* 41A	750.	RF Microwattmeter
51A	2,500.	AC Null Detector (rack mounting)
* 56A	495.	DC Null Detector
* 56A-S2	550.	DC Null Detector, 40 Megohm Input
63H	2,300.	Inductance Bridge (5-500 KHz)
63L	2,300.	Inductance Bridge (400 Hz-40 KHz)
63M	2,300.	Inductance Bridge (1-100 KHz)
71A	875.	Capacitance/Inductance Meter (1 MHz)
71A-R	950.	Rack Mtg. Mod. 71A; includes built in Cap. Std. & Q Check
71C-R	995.	Capacitance/Inductance Meter (100 KHz) Rack Mtg. Model; built in Cap. Std. & Q Check
71D	2,500.	Digital Capacitance/Inductance Meter (1 MHz)
74D	1,595.	Capacitance Bridge (100 KHz; 0.1%; dc bias; limit/norm. detector)
75C	2,200.	Capacitance Bridge (5-500 KHz; dc bias)
75D	1,595.	Capacitance Bridge (1 MHz; dc bias low C range; phase sensitive detector)
77B	2,300.	Automatic Capacitance Limit Bridge (1 MHz)
77B-S1	2,300.	Automatic Capacitance Limit Bridge (100 KHz)
* 91C	550.	RF Voltmeter (incl. Probe, Tip, 50 Ω Adapter)
* 91C-S4	680.	RF Voltmeter (400 Hz operation; incl. Probe, Tip, 50 Ω Adapter)
* 91C-S5	550.	RF Voltmeter (dBm scale; incl. Probe, Tip, 50 Ω Adapter)
* 91C-S7	680.	RF Voltmeter (400 Hz; dBm scale; incl. Probe, Tip, 50 Ω Adapter)
* 91H	650.	RF Voltmeter (incl. Probe, Tip, 50 Ω Adapter)
* 91H-S4	780.	RF Voltmeter (400 Hz operation; incl. Probe, Tip, 50 Ω Adapter)
* 91H-S5	650.	RF Voltmeter (dBm scale; incl. Probe, Tip, 50 Ω Adapter)
* 91H-S7	780.	RF Voltmeter (400 Hz; dBm scale; incl. Probe, Tip, 50 Ω Adapter)
* 91DA	700.	RF Voltmeter (incl. Probe, Tip, 50 Ω Adapter)
* 91DA-S5	700.	RF Voltmeter (dBm scale; incl. Probe, Tip, 50 Ω Adapter)

Complete Accessory Kit, (when purchased with any of the above RF Voltmeters) — price \$ 1.25. Includes 91-6C; 91-7C; 91-14A; 91-15A; 91-18A; and storage space for Probe, Tip and 50 Ω Adapter provided with each instrument.

* 95A 600. Sensitive DC Meter

There are many special versions of instruments, designated by —S numbers, not shown. Prices of these units will be quoted on request.

50 Hz (117V or 220V) versions of all instruments available at no extra cost.
Add \$50.00 for special paint.
* Add \$25.00 for rack mounting version.
For prices of RF Voltmeter and Bridge Accessories see reverse side.

VOLTMETER ACCESSORIES

Model	Unit Price	Description
91-4C	\$75.	Special 1 KHz-250 MHz RF Probe
91-6C	25.	Unterminated Adapter (BNC)
91-7C	40.	100:1 Voltage Divider
91-8B	30.	50 Ω Adapter (BNC)
91-8B-1	30.	75 Ω Adapter (BNC)
91-8B-2	30.	93 Ω Adapter (BNC)
91-8B-3	30.	72 Ω Adapter (BNC)
91-8B-4	30.	90 Ω Adapter (BNC)
91-8B-5	30.	95 Ω Adapter (BNC)
91-8B-6	30.	60 Ω Adapter (BNC)
91-8B-7	30.	20 Ω Adapter (BNC)
91-8B-8	30.	200 Ω Adapter (BNC)
91-8B-9	30.	52 Ω Adapter (BNC)
91-12D	65.	RF Probe**
91-12E	55.	RF Probe for all current RF Voltmeters
91-13B	5.	Probe Tip
91-14A	45.	"Tee" Adapter (Type N)
91-15A	25.	50 Ω Termination for 91-14A (Type N)
91-16A	25.	Unterminated Adapter (Type N)
91-17D	75.	Special 1 KHz-250 MHz RF Probe**
91-18A	15.	Accessory Storage Box
91-19B	15.	Accessory Storage Bracket

** For replacement in Model 91DA's with Serial Numbers below 8535 only.

BRIDGE ACCESSORIES

CS	\$100.	Capacitance Standard for 74, 75, & 77 Series
TS1	5.	Terminal Shield
33-1A	60.	Dielectric Sample Holder for Model 33 Series
33-2A	60.	Diode Test Jig for Model 33 Series
33-3A	60.	Type N 50 Ω Adapter for Model 33 Series
33-4A	120.	Set of 7 work coils (with storage container) for capacitance measurement with Models 33A & 33B
33-5A	120.	Set of 7 work coils (with storage container) for capacitance measurement with Models 33C & 33D
33-6A	120.	Set of 7 work coils (with storage container) for inductance measurement with Models 33A & 33B
33-7A	120.	Set of 7 work coils (with storage container) for inductance measurement with Models 33C & 33D
33-8A	40.	Zero Conductance Standard
33-9A	30.	Capacitance Standard for Model 33 Series
33-10A	30.	Conductance Standard for Model 33 Series
33-11A	30.	Range Extending Capacitor for 33A
33-12A	25.	Range Extending Work Coil for 33A
33-13A	15.	Storage Case for 8 Work Coils for 33 Series
33-14A	350.	Set of Capacitance and Conductance Standards in Storage Case for 33A
33-15A	25.	Test Signal Attenuator for use with 33C
41-1A	160.	Power Detector for 41A
41-2A	15.	Power Detector Cable for 41A
63-11B	100.	Mu Jig for use with 63H, 63L, or 63M
63-15A	100.	Inductance Standard (1 μ H)
71-1A	60.	100 pF Capacitance Standard & Q Check for Model 71A
75-1A	25.	Fixed 40 dB Test-Signal Attenuator for 74 & 75 Series
75-2A	230.	Oscillator/Detector (100 KHz) for 75A
75-3A	230.	Oscillator/Detector (465 KHz) for 75A
75-5A	120.	Three to Two Terminal Adapter for 74, 75, & 77 Series Bridges
77-1A	120.	Remote Test Jig for Model 77B and 77B-S1
77-2A	175.	Capacitance Range Extender, 1 MHz for 75D & 77B
77-3A	175.	Capacitance Range Extender, 100 KHz for 74 Series
77-5A	120.	Capacitance Range Divider (10:1, 100 KHz) for 71C-R and 74 Series
77-4A	120.	Capacitance Range Divider (10:1, 1 MHz) for 71A, 71A-R, 71D, 75A Series, 75D, and 77B

All prices F.O.B. Parsippany, New Jersey
State and local taxes not included.
Minimum order value, \$15.00

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Terms: Net 30 days

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Capacitance Limit Bridge 1 MHz Model 77B

Automatic, high-speed, dual or single limit tests, or conventional manual measurements of capacitance or inductance. In automatic mode, test is insensitive to specimen loss. "High," "Low," or "Go" test decisions indicated by front panel lamps as well as by continuity closures for actuation of materials handling equipment. Internally supplied crystal controlled 1 MHz test signal. Operates with low test level. Built in dc bias supply; provision for external bias. 3-terminal arrangement permits remote tests.

Capacitance Measurements: Automatic Mode, 0 to 1000 pF with 0.001 pF resolution; Manual 0 to 1000 pF with 0.0001 pF resolution; basic accuracy $\pm 0.25\%$

Inductance Measurement: Manual or Automatic, 25 μH to ∞ ; basic accuracy, $\pm 0.25\%$

Conductance Measurement: (Manual only) 0 to 1000 μhos ; basic accuracy, $\pm 5\%$; resolution, 0.05 μmho

Tolerance Limits: Programmable at front panel controls from ± 0.0005 pF to ± 200 pF; basic accuracy, $\pm 1\%$ of limit setting.

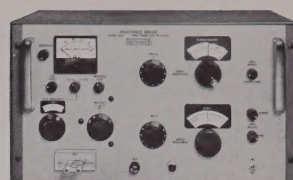
Test Time: Approx. 50 ms

Test Signal: Internally supplied; 1 MHz, crystal controlled; level adjustable from 250 mV to 15 mV for Automatic Mode, to 1 mV for Manual Mode

Decision Output: Green, red, and amber panel lamps indicating "Go", "High", "Low", respectively; continuity contacts available at rear panel in conformance with test decisions

DC Bias: Internal, continuously adjustable from -6V to $+150\text{V}$; external, to $\pm 400\text{V}$.

Price: \$2,000.00



Inductance Bridges Models 63H, 63M, 63L

Direct reading measurements of inductance and series resistance. Test frequency adjustable over 100:1 range. Completely self-contained, including test oscillator and detector. Convenient operation, with false nulls and sliding balance eliminated. Outstanding stability. Particularly useful for quality assurance or production tests, as well as for laboratory studies.

Model 63H

Inductance Measurement: 0 to 110 mH; accuracy, $\pm 0.25\%$; resolution, 0.0002 μH

Series Resistance Measurement: 0.0002 Ω to 11,000 Ω ; accuracy, $\pm 3\%$

Test Signal: Internal oscillator-detector continuously adjustable from 5 KHz to 500 KHz; max. open-circuit level, 3V

Model 63M

Inductance Measurement: 0 to 1.1 H; accuracy, $\pm 0.25\%$; resolution, 0.002 μH

Series Resistance Measurement: 0.0002 Ω to 110,000 Ω ; accuracy, $\pm 3\%$

Test Signal: Internal oscillator-detector continuously adjustable from 1 KHz to 100 KHz; max. open-circuit level 5.5V

Model 63L

Inductance Measurement: 0 to 11H; accuracy, $\pm 0.25\%$ resolution, 0.02 μH

Series Resistance Measurement: 0.005 Ω to 110,000 Ω ; accuracy $\pm 3\%$;

Test Signal: Internal oscillator-detector continuously adjustable from 400 KHz to 40 KHz; max. open-circuit level 5.5V

Price: Models 63H, 63M, and 63L, \$1,995.000

Automation Products

In addition to the equipment shown in this catalog, Boonton Electronics Corporation also produces a line of instruments and systems for high-speed, automatic testing and manufacturing process control in electronic component and microcircuit production. This line includes: automatic resistance limit bridges, automatic resistance trimming bridges, automatic capacitance test systems, and resistance and capacitance scanning systems, among many others. Full information on this equipment is provided in our catalog of "Automation Products," which is available on request.

Capacitance Limit Bridge 100 KHz Model 77B-S1

Essentially similar to Model 77B. Has basic capacitance and inductance accuracy of $\pm 0.1\%$. Operates with internally supplied 100 KHz crystal controlled test signal. Capacitance range, automatic or manual is 0.001 pF to 1000 pF. Inductance range, 2.5 mH to ∞ . Otherwise specifications are as shown for Model 77B.

Price: \$2,000.00

VOLTMETER ACCESSORIES

Model	Unit Price	Description
91-4C	\$ 75.	Special 1 KHz-250 MHz RF Probe
91-6C	25.	Unterminated Adapter (BNC)
91-7C	40.	100:1 Voltage Divider
91-8B	30.	50 Ω Adapter (BNC)
91-8B-1	30.	75 Ω Adapter (BNC)
91-8B-2	30.	93 Ω Adapter (BNC)
91-8B-3	30.	72 Ω Adapter (BNC)
91-8B-4	30.	90 Ω Adapter (BNC)
91-8B-5	30.	95 Ω Adapter (BNC)
91-8B-6	30.	60 Ω Adapter (BNC)
91-8B-7	30.	20 Ω Adapter (BNC)
91-8B-8	30.	200 Ω Adapter (BNC)
91-8B-9	30.	52 Ω Adapter (BNC)
91-12D	65.	RF Probe**
91-12E	55.	RF Probe for all current RF Voltmeters
91-13B	5.	Probe Tip
91-14A	45.	"Tee" Adapter (Type N)
91-15A	25.	50 Ω Termination for 91-14A (Type N)
91-16A	25.	Unterminated Adapter (Type N)
91-17D	75.	Special 1 KHz-250 MHz RF Probe**
91-18A	15.	Accessory Storage Box
91-19B	15.	Accessory Storage Bracket

** For replacement in Model 91DA's with Serial Numbers below 8535 only.

BRIDGE ACCESSORIES

CS	\$ 100.	Capacitance Standard for 74, 75, & 77 Series
TS1	5.	Terminal Shield
33-1A	60.	Dielectric Sample Holder for Model 33 Series
33-2A	60.	Diode Test Jig for Model 33 Series
33-3A	60.	Type N 50 Ω Adapter for Model 33 Series
33-4A	120.	Set of 7 work coils (with storage container) for capacitance measurement with Models 33A & 33B
33-5A	120.	Set of 7 work coils (with storage container) for capacitance measurement with Models 33C & 33D
33-6A	120.	Set of 7 work coils (with storage container) for inductance measurement with Models 33A & 33B
33-7A	120.	Set of 7 work coils (with storage container) for inductance measurement with Models 33C & 33D
33-8A	40.	Zero Conductance Standard
33-9A	30.	Capacitance Standard for Model 33 Series
33-10A	30.	Conductance Standard for Model 33 Series
33-11A	30.	Range Extending Capacitor for 33A
33-12A	25.	Range Extending Work Coil for 33A
33-13A	15.	Storage Case for 8 Work Coils for 33 Series
33-14A	350.	Set of Capacitance and Conductance Standards in Storage Case for 33A
33-15A	25.	Test Signal Attenuator for use with 33C
41-1A	160.	Power Detector for 41A
41-2A	15.	Power Detector Cable for 41A
63-11B	100.	Mu Jig for use with 63H, 63L, or 63M
63-15A	100.	Inductance Standard (1 μ H)
71-1A	60.	100 pF Capacitance Standard & Q Check for Model 71A
75-1A	25.	Fixed 40 dB Test-Signal Attenuator for 74 & 75 Series
75-2A	230.	Oscillator/Detector (100 KHz) for 75A
75-3A	230.	Oscillator/Detector (465 KHz) for 75A
75-5A	120.	Three to Two Terminal Adapter for 74, 75, & 77 Series Bridges
77-1A	120.	Remote Test Jig for Model 77B and 77B-S1
77-2A	175.	Capacitance Range Extender, 1 MHz for 75D & 77B
77-3A	175.	Capacitance Range Extender, 100 KHz for 74 Series
77-5A	120.	Capacitance Range Divider (10:1, 100 KHz) for 71C-R and 74 Series
77-4A	120.	Capacitance Range Divider (10:1, 1 MHz) for 71A, 71A-R, 71D, 75A Series, 75D, and 77B

All prices F.O.B. Parsippany, New Jersey

State and local taxes not included.

Minimum order value, \$15.00

Prices and specifications subject to change without notice.

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Sensitive RF Voltmeters

The 91 Series RF Voltmeters provide reliable, reproducible voltage measurements from the low radio frequencies to the gigahertz region over a wide range of amplitudes. The versatility of these instruments plus their accuracy and convenience of operation have established them as standards of performance for the industry. The primary differences between the Models 91DA, 91H and 91C are indicated in the specification table below. All three models are characterized by low noise, excellent stability, high input impedance, and low input capacitance.



	Model 91DA	Model 91H	Model 91C
Voltage Range:	1 mV fs to 3 V fs*	1 mV fs to 3 V fs*	3 mV fs to 3 V fs*
	*to 300 V with Model 91-7C 100:1 Voltage Divider		
Voltage Sensitivity:	300 μ V	100 μ V	1 mV
Power Sensitivity, (50 Ω):	0.0018 μ W	0.0002 μ W	0.02 μ W
Basic Accuracy:	$\pm$ 2%, fs	$\pm$ 3%, fs	$\pm$ 5%, fs
Frequency Range:	20 KHz to 1200 MHz, with uncalibrated response to 4000 MHz		
VSWR:	Less than 1.2 up to 1200 MHz for all Models		
Waveform Response:	True rms up to 0.03 V (to 3 V with accessory 100:1 Voltage Divider) gradually approaching peak-to-peak (calibrated in rms) above this level.		
DC Output	yes	yes	no
dB Range	80 dB	80 dB	70 dB
Price:	\$650.00**	\$595.00**	\$495.00**
	\$750.00†		

**Includes 91-12E RF Probe, 91-13B Probe Tip, and 91-8B 50 ohm Adapter

†With complete Accessory Kit, consisting of 91-12E RF Probe, 91-13B RF Probe Tip, 91-6C Unterminated BNC Adapter, 91-7C 100:1 Voltage Divider, 91-8B 50 ohm Adapter, 91-14A Tee Adapter, 91-15A 50 ohm Termination, all in 91-18A Accessory Storage Box.

Accessories for RF Voltmeters:

		Price
91-4C	1 KHz to 250 MHz Probe	\$65.00
91-6C	Unterminated BNC Adapter	20.00
91-7C	100:1 Voltage Divider (50 KHz to 700 MHz)	35.00
91-8B	50 Ω BNC Adapter (20 KHz to 600 MHz; other impedances also available)	25.00
91-12E	20 KHz to 1200 MHz Probe	45.00
91-13B	RF Probe Tip	3.00
91-14A	Type N "Tee" Adapter (20 KHz to 1200 MHz)	35.00
91-15A	50 Ω Type N Termination (20 KHz to 1200 MHz)	25.00
91-16A	Unterminated Type N Adapter	20.00
91-18A	Accessory Storage Box	10.00



Sensitive DC Null Detector Model 95A

Electronic galvanometer providing exceptionally high sensitivity and high input impedance. Especially valuable as indicator in conjunction with Wheatstone

Bridge. Either floating or grounded operation. Zero-center scale. 60 dB scale compression in Hunt mode virtually eliminates range switching when measuring specimens of unknown value. Provision for remote Hunt mode switching. Amplifier output available at front panel terminals. **Voltage Range:** 10 μ V to 100 V, end scale, in 8 ranges; sensitivity, 1 μ V **Current Range:** 1 pA to 10 μ A, end scale; sensitivity, 0.1 pA **Input Resistance:** 10 M Ω , all ranges **Operating Modes:** Hunt (60 dB meter scale compression); Calibrate (linear meter scale) **Amplifier Output Capability:** $\pm$ 1 mA dc into 1000 Ω **Amplifier Gain:** $-$ 40 to $+100$ dB. **Price:** \$495.00 (rack mounted Model 95A-R, \$520.00)



RF Microwattmeter Model 41A

Exceptionally stable microwave power meter providing reliable measurements over a 70 dB range with one power detector. Use of full-wave diode detector overcomes limitations of stability, sensitivity, and overload of thermal types. No zero balancing except for fractional microwatt measurements. Can be calibrated from low frequency rf source. Stable dc output. **Power Range:** 0.01 μ W (-50 dBm) fs to 10 mW ($+10$ dBm) fs **Power Sensitivity:** 0.001 μ W (-60 dBm) **Frequency Range:** 100 KHz to 7 GHz **Basic Accuracy:** $\pm$ 0.5 dB **Drift:** Less than 0.001 μ W per hour **VSWR:** 1.3 to 3 GHz; 1.5 to 6 GHz; 1.8 to 7 GHz **Overload Limit:** Input of 300 mW cw does not cause damage **Price:** 41A, \$695.00; rack mounting Model 41A-R, \$720.00



Sensitive DC Micro-volt/Picoammeter Model 95A

Unusually broad range of dc voltage and current measurements covered in 42 ranges. Front panel range and function switching uniquely simple and convenient. Zero center meter. Fast response. Exceptionally stable amplifier output at front panel. Amplifier output gain and reference level adjustable without interaction with meter. Either floating or grounded operation for voltage; floating for current. **Voltage Range:** 10 μ V to 1000 V, end scale; accuracy, $\pm$ 3%; sensitivity, 1 μ V **Current Range:** 1 pA to 1 A, end scale; accuracy, $\pm$ 4%; sensitivity, 0.1 pA **Voltmeter Input Resistance:** 10 M Ω , all ranges **Amplifier Output:** $\pm$ 1 V, end scale, across 1000 Ω **Amplifier Gain:** 100,000 max **Price:** \$550.00 (rack mounted Model 95A-R, \$575.00)



Capacitance/Inductance Meter Model 71A

Quick, convenient, direct reading, 3-terminal measurements of capacitance or 2-terminal measurements of inductance. Internally supplied 1 MHz test signal. 3-terminal arrangement permits remote capacitance measurements. Accommodates both high and low Q devices. Operates with low test signal level, permitting semiconductor tests. Rapid response. Linear meter scales. Provision for dc bias. Precise dc analog output proportional to capacitance or inductance reading; useful for display on dvm, x-y plotter, or strip-chart recorder; usable for go/no-go testing with suitable voltage comparator. **Capacitance Measurement:** 0 to 1000 pF in 7 ranges; basic accuracy, $\pm$ 1%; resolution, 0.25% **Inductance Measurement:** 0 to 1000 μ H in 7 ranges; basic accuracy, $\pm$ 1%; resolution, 0.25% **Test Signal:** Frequency, 1 MHz, crystal controlled; level, 15 mV rms for capacitance measurements, <1 mV for inductance measurements **Q Range:** Specified accuracy applies for test specimens having Q's of 3 or more; lower with readjustment **DC Bias:** External up to $\pm$ 200 V **DC Analog Output:** Up to 100 mV or 300 mV fs depending on range numerics; also >1 V fs for loads >10 M Ω ; linearity, 0.1% of reading $+0.005\%$ fs; response time, <10 ms **Price:** \$795.00; rack-mounting version with built-in standard, Model 71A-R, \$870.00



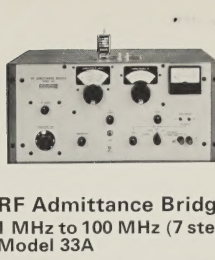
Digital Capacitance/Inductance Meter Model 71D

Digital readout of 3-terminal capacitance or 2-terminal inductance at 1 MHz. Provision for remote capacitance measurements



Capacitance Bridge Model 75D

A new capacitance bridge directly replacing Boonton 75A and 75B series. Includes many features specifically designed for semiconductor testing. Outstanding resolution and stability. Embodies a phase sensitive detector which provides capacitance measurements independent of conductance; also permits use as single limit bridge. Amplitude detector is included for conventional capacitance/loss studies. 3-terminal arrangement permits remote measurements without errors resulting from cable capacitance to ground. Provision for measuring equivalent inductance. Operates with low test signal levels. Convenient operation without false nulls or sliding balance. Single internal or dual external bias. **Capacitance Measurement:** 0 to 1000 pF; basic accuracy, $\pm$ 0.25%; resolution, 0.00005 pF with phase sensitive detector; 0.0005 pF with amplitude sensitive detector **Conductance Measurement:** 0 to 1000 μ hos; basic accuracy $\pm$ 5%; resolution, 0.01 μ ho **Inductance Measurement:** 25 μ H to ∞ ; basic accuracy, $\pm$ 0.25% **Test Signal:** 1 MHz, crystal controlled; level adjustable from 1 mV to 250 mV **Dual External DC Bias:** HI to GND and/or LO to GND; differential, $\pm$ 400 V max. **Internal DC Bias:** HI to LO; -6 V to $+150$ V **Price:** \$1,595.00



RF Admittance Bridge Model 33A

Precise, high resolution measurement of capacitance and loss at high frequencies and with low test signal levels. Shunt inductance, series and shunt resistance, dissipation factor, and Q can also be readily determined. Designed specifically for semiconductors and integrated circuits. Built-in dc bias supply with provision for external bias. **Capacitance Measurement:** 0 to 150 pF from 1 MHz to 50 MHz; 0 to 30 pF at 100 MHz; basic accuracy, $\pm$ 1%; resolution, 0.02 pF **Conductance Measurement:** 0 to 25,000 μ hos; basic accuracy, $\pm$ 2%; resolution, 0.5 μ ho **Test Signal:** 7 internally supplied crystal frequencies of 1.5, 5, 10, 20, 30, 50, and 100 MHz; level continuously adjustable from 100 mV down to as low as 1 mV **DC Bias:** Internal, continuously adjustable from -5 V to $+100$ V; external, to $\pm$ 250 V **Price:** \$2,200.00 **Ultra High Capacitance Resolution RF Admittance Bridge Model 33A-S7** Capacitance range, 0 to 15 pF with resolution of 0.002 pF. Otherwise identical to Model 33A. **Price:** \$2,350.00

Ultra High Conductance Resolution RF Admittance Bridge Model 33B

Conductance range 0 to 5000 μ hos with resolution of 0.1 μ ho. Otherwise identical to Model 33A. **Price:** \$2,700.00

Model CS Capacitance Standards

Precision standards for checking accuracy or calibrating three-terminal capacitance bridges, or for use as highly stable references for temperature coefficient measurements or other comparison studies; available in any value from 0.01 pF to 1000 pF; frequency range, 1 MHz to 1 KHz; basic accuracy, 0.1%; calibrated against reference standards directly traceable to the National Bureau of Standards. **Price:** \$75.00



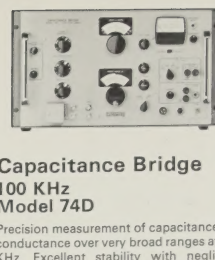
Q Bridge Model 35A

Dramatically new non-resonant 3-terminal bridge. Provides direct reading measurements of capacitance up to large values and Q over wide ranges, with continuously adjustable test frequency. Remote measurements possible at low frequencies. Test signal continuously adjustable to low levels; can be measured by front panel meter; once set, level remains constant regardless of bridge balance. No work coils. Single internal or dual external dc bias. **Capacitance Measurements:** Range, 2 pF to 1000 pF up to 50 MHz; to 10,000 pF up to 10 MHz; basic accuracy, $\pm$ 0.5% **Q Measurements:** 5 to 10,000; basic accuracy, $\pm$ 5% for Q's up to 30, $\pm$ 10% for Q's up to 10,000 **Test Signal:** Frequency continuously adjustable from 100 KHz to 50 MHz; level continuously adjustable from 0.2 mV to 250 mV **Dual External DC Bias:** HI to GND and/or LO to GND; differential $\pm$ 200 V max. **Internal DC Bias:** HI to LO, 0 to 150 V **Price:** \$2,500.00 (Tentative)



Capacitance Bridge Model 75C

An accurate, reliable bridge widely used throughout the industry for 1 MHz capacitance and loss measurements of semiconductors. 3-terminal arrangement permits remote tests without errors resulting from cable capacitance to ground. 2-terminal operation also provided. Operable as comparison bridge. Test signal continuously adjustable to low values. Internal or external dc bias. **Capacitance Measurement:** 0 to 1000 pF; basic accuracy, $\pm$ 0.25%; resolution, 0.0002 pF **Conductance Measurement:** 0 to 1000 μ hos; basic accuracy, $\pm$ 5%; resolution, 0.01 μ ho **Test Signal:** Internally supplied, 1 MHz; level continuously adjustable from 20 mV to 4 V **DC Bias:** Internal, continuously adjustable from -6 to $+110$ V; external, to $\pm$ 400 V **Price:** \$1,325.00



Capacitance Bridge Model 74D

Precision measurement of capacitance and conductance over very broad ranges at 100 KHz. Excellent stability with negligible warm-up drift. Test signal level adjustable to low values for semiconductor testing. 3-terminal arrangement permits use of remote test jig without errors owing to cable capacitance to ground. 2-terminal operation also provided. "Linear" mode for limit operation permits go/no go testing. Provision for differential or comparison measurements. Balancing simple and convenient, with no false or sliding nulls. Internally supplied or external dc bias. **Capacitance Measurement:** 0 to 110,000 pF; basic accuracy, $\pm$ 0.1%; resolution, 0.0002 pF. **Conductance Measurement:** 0 to 1000 μ hos; basic accuracy, $\pm$ 5%; resolution, 0.001 μ ho **Test Signal:** Internally supplied, 100 KHz; level continuously adjustable from 1 mV to 4 V **DC Bias:** Internal, -6 V to $+110$ V; External, up to $\pm$ 400 V **Price:** \$1,350.00



Variable Frequency Capacitance Bridge Model 75C

Versatile 3-terminal bridge with adjustable test frequency. Permits determination of effects of frequency upon components or materials. Includes built-in dc bias supply. Convenient operation. False and sliding nulls eliminated. Completely self-contained including bridge circuit, tunable oscillator and detector. **Capacitance Measurement:** 0 to 1000 pF; basic accuracy, $\pm$ 0.25%; resolution, 0.0002 pF **Conductance Measurement:** 0 to 1000 μ hos; basic accuracy, $\pm$ 5%; resolution 0.001 μ ho **Test Signal:** Internally supplied; continuously adjustable in frequency from 5 KHz to 500 KHz; level adjustable from 1 mV to 3 V **DC Bias:** Internal only; continuously adjustable from -5 V to $+100$ V **Price:** \$1,900.00

Gentlemen: ☐ Please send me technical information on: ☐ I have a current need for equipment of this type ☐ General interest only ☐ Please have your Sales Engineering Representative phone for an appointment. Name _____ Title _____ Company _____ Address _____ Zip code _____ CC-11 If we can assist you in any other way, please indicate how we may be of service: Phone: _____ Ext: _____

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TWX: 612-551-0914

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Tel: 305-293-5202
TWX: 810-850-0138

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Tel: 206-323-5100
TWX: 910-444-2154

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301-588-7866

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15 Home Office
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Parsippany, N. J. 07054
Tel: 201-887-5110
TWX: 710-986-8241

16 Micro Sales Corp.
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Dayton, Ohio 45409
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2000 Lee Road
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Tel: 216-371-0522

22050 W. McNichols
Detroit, Mich. 48219
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101 Investment Bldg.
239 4th Ave.
Pittsburgh, Penn. 15222
Tel: 412-281-3228

BOONTON
ELECTRONICS
CORPORATION

All prices are fob Parsippany, New Jersey, and do not include applicable federal, state, or local taxes. Prices and specifications are subject to change without notice.

Telephone: 201-887-5110 ■ TWX: 710-986-8241 ■ Route 287, Parsippany, N. J. - 07054

Printed in U.S.A.

Warranty

Boonton Electronics Corporation warrants its products to the original Purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to vacuum tubes that have given normal service, to sealed assemblies which have been opened, or to any item which has been repaired or altered without our authorization.

We will repair or, at our option, replace at no charge any of our products which are found to be defective under the terms of this warranty.

SHIPPING INSTRUCTIONS

If it becomes necessary to ship the instrument, the following steps should be followed:

- a. Wrap the instrument with heavy wrapping paper and seal the seams with gummed tape. Place in fibreboard carton large enough to permit three inches of soft packing material between instrument and sides of box.
- b. Wrap and pad the RF Probe and all accessories and include them in the carton with the Voltmeter. Be sure the serial number of the Probe matches that of the voltmeter.
- c. Alternatively Boonton Electronics will provide an appropriate shipping container and packing materials at nominal cost. These may be obtained by writing to the Sales Department, Boonton Electronics Corporation, Route 287 at Smith Rd., Parsippany, N. J. 07054.

Models 91H & 91HR



Models 91H & 91HR